Intercomparison of Data-Driven Estimation of Soil Respiration in Japan

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Soil Respiration (SR), the sum of root respiration and heterotrophic respiration, is one of the most essential components of soil carbon cycles. However, large uncertainties remain in its temporal and spatial variations. So far, various efforts have been conducted to understand SRs. Many observation stations directly measure SR using chambers. Using these observation data and literature survey, several studies estimated spatial and temporal patterns of SR at global and regional scales based on semi-empirical equations and machine-learning methods. However, the database (e.g. Soil Respiration Database; SRDB) used in these large-scale studies contains inconsistently observed datasets. These inconsistencies may produce additional uncertainties in estimated fluxes. The largest SR observation network across Asia developed and maintained by NIES, Japan can be a good candidate to estimate spatio-temporal variations in SR across Asia, since these observations have been conducted with a consistent observation protocol and quality controls.

In this study, we updated our data-driven estimation of SR across Japan with observation data (eight sites across Japan), remote sensing data (MODIS land products), and random forest regression. Our estimation shows a reasonable performance with R^2=0.87 for remote sensing only model and R^2=0.91 for remote sensing and in-situ combined model. Based on the established model, we also produced upscaled estimations of SR across Japan with 1km spatial resolution from 2000 to 2020.

Intercomparison of our estimation with other available datasets was also conducted to understand advantages of our estimation. Our results show spatially more explicit variations compared with other global products. In addition, our advantage is to capture temporal variations (e.g. 8days). We also confirmed that previous estimations do not reproduce our observation network datasets, indicating consistent observation approach is important to upscale soil respiration.

Keywords: Carbon Cycle, Soil Respiration, Remote Sensing, Machine Learning, Upscaling, CO2 Flux

